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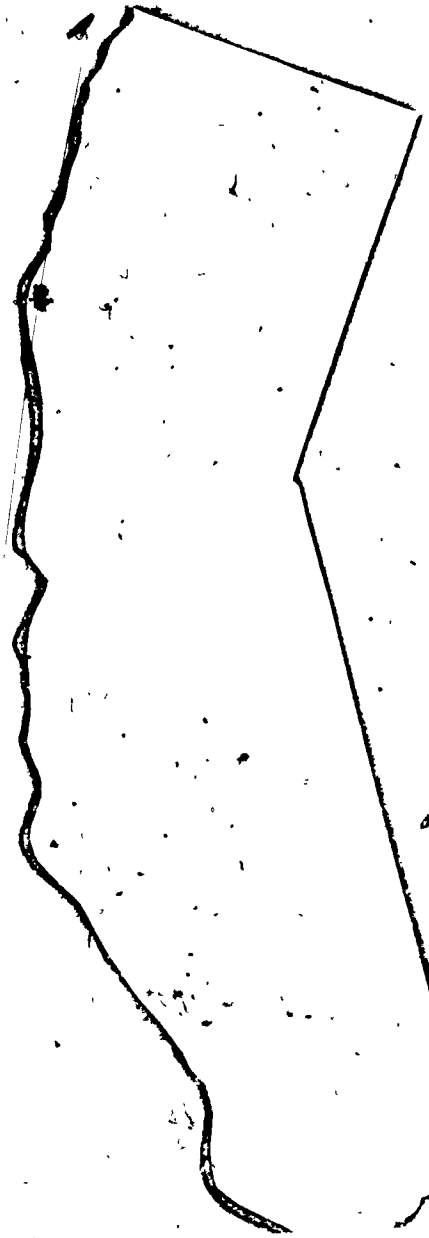
ABSTRACT

This paper addresses the issue of how learning in classrooms takes place. The effects of different curriculum and different teaching methods in knowledge acquisition is examined, both as main effects and in interaction with student attitudes. The role of the teacher in communicating the knowledge to be acquired is described. Teachers are viewed as effective in helping students acquire knowledge if they engage in direct instruction. Components of direct instruction are described and data on their relationship to outcomes is presented. (Authors)



THE ACQUISITION OF KNOWLEDGE

IN THE CLASSROOM

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PREFACE

This report, supported in part by the United States Navy Personnel Research and Development Center, was prepared for a conference that they sponsored on Schooling and the Educational Process, held in San Diego, California, November 20-22, 1975. Work on this report was also supported by the California Commission for Teacher Preparation and Licensing, through funds provided by the National Institute of Education for the Beginning Teacher Evaluation Study (BTES).

The California Commission is the agency charged with certifying the appropriateness of teacher training programs throughout the State. Simply put, the Commission wants information about what teacher behaviors are related to student outcomes. This information will then be used jointly by the Commission and the State institutions that it certifies in order to better insure that beginning teachers receive training in areas that have been empirically demonstrated to affect student learning. The research engaged in by the BTES staff tries to provide the Commission with the information it requires.

The Principal Investigator of the BTES project (David C. Berliner) and a member of the California Commission's Research Advisory Board (Barak Rosenshine) co-authored this paper to present some ideas about how instruction in general, and direct instruction in particular, affect the acquisition of knowledge in the classroom. This paper is concerned

with the effects of the curricula to be taught, the method by which information is communicated, and the teacher's role in fostering the acquisition of knowledge and skills. The BTES staff shares, with other researchers, a growing belief that direct instruction is a causal factor in student achievement.

As in other documents of the Far West Laboratory, the views presented in this paper are not necessarily endorsed either by the California Commission for Teacher Preparation and Licensing, the United States Navy Personnel Research and Development Center, or the National Institute of Education.

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February 1976

THE ACQUISITION OF KNOWLEDGE IN THE CLASSROOM[1]

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Any description of how knowledge is acquired in the classroom must, at a minimum, focus on three critical areas. These areas are the curricula to be taught, the method by which information is communicated, and the teacher's role in fostering the acquisition of knowledge and skills so that classroom instruction is interesting, comprehensible, and pleasant. An examination of these three concerns will lead to some simple principles about how students learn in classrooms, particularly at the primary grades.

The Curricula to be Taught

The question of what is to be taught is usually answered, in a general way, through the guidelines set forth by state curriculum committees. At a more specific level, the issue is settled by commercial publishers. The curriculum materials in use, to a large degree, define the knowledge to be acquired by students and thus define for the teacher what

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1 This report will appear as a chapter in Schooling and the Educational Process, edited by R.C. Anderson, R.J. Spiro, and W.E. Montague, published by Earlbaum Associates of Hillsdale, New Jersey. This book will be published late in 1976.

2 Dr. Margaret Bierly, Department of Psychology, California State University at Chico, assisted in the development of this paper.

is to be taught. Curriculum evaluation studies may, therefore, provide some insight into how bodies of knowledge are acquired by students.

Walker and Schaffarzick (1974) examined over twenty studies that compared students exposed to different curricula in the same subject area. Usually, these studies were like horse races comparing an innovative curriculum with a traditional one. The most interesting part of their review was a comparison of results where the achievement tests of knowledge acquired from the different curricula were analyzed by the content bias of those tests. Table 1 presents these findings.

INSERT TABLE 1 HERE

These data make clear that "innovative groups are overwhelmingly superior on tests biased in their direction, and traditional groups do noticeably, but not overwhelmingly, better on tests biased their way (Walker and Schaffarzick, 1974, pp. 92-93)." One of the curriculum studies provided a comparison of a new math textbook (SMSG) with a traditional textbook. The investigators found that use of the new math textbook was associated with increased student achievement on tests measuring comprehension of mathematics, and with lower student performance on tests measuring computational ability. Conversely, use of the traditional textbook was associated with increased performance on tests of computational skills, and lower performance on tests of mathematical comprehension (Wilson, Cahen, and Beale, 1970). In an international study of mathematics achievement, it was concluded that there is a striking relationship between the national emphasis on particular curriculum areas, as rated by teachers within a country, and the student's achievement in that country (Husen, 1967).

The conclusion to be drawn from these studies is that one curriculum is neither intrinsically better nor worse than another, but rather that different curricula result in different patterns of acquiring knowledge. What knowledge is acquired depends on the coverage and emphasis of the curriculum in use. When curricula differ, they will produce different levels of outcomes. When curricula have common areas of concern, they will show parity, producing outcomes of equal magnitudes for those areas given similar coverage and emphasis.

This brief and highly selective review of curriculum evaluation leads to the conclusion that different curricula have equipotentiality for inducing knowledge acquisition in the classroom. Data aggregated at the classroom level indicate that for differing curricula whose coverage and content emphasis are similar, the amount and types of knowledge acquired will be roughly equivalent, when measured by nonbiased achievement tests.

These results, however, do not imply that individual students acquire knowledge in similar ways. Different types of curricula require different teaching methods (e.g., inductive vs. deductive) and can be classified as relatively structured or unstructured. These kinds of curriculum differences interact with student characteristics when analysis of curriculum outcomes includes individual student data. For example, Chastain (1970) found three clear-cut aptitude-treatment interactions where treatment was a curriculum. These interactions are presented in Table 2. Student outcomes are shown to vary in the different curricula when verbal ability is taken into account. Overall mean differences between curricula are not evident.

INSERT TABLE 2 HERE

Another curriculum study using the student as the unit of analysis examined the whole-word and linguistic (decoding) methods of teaching initial reading (Stallings and Keepes, 1970). Disordinal interactions were found between certain aptitudes measured by the Illinois Test of Psycholinguistic Abilities (ITPA) and student outcomes. In some cases, the whole-word method led to superior student acquisition of knowledge and skills in beginning reading, and in other cases, the linguistic method was superior, depending upon students' ITPA aptitudes.

The conclusion to be drawn from this line of research is that differing curricula have differential potentiality for inducing the acquisition of knowledge when the student is used as the unit of analysis. The concepts of equipotentiality and differential potentiality are also useful for examining the teaching methods used to communicate the information to be acquired by students.

The Method of Communication

Teachers have a choice in the method they use to present a curriculum. Types of methods, or recurrent instructional strategies, applicable to various subject matters, include the following:

- patterned teacher behavior (e.g., lecturing, discussion, recitation);
- delivery systems for curriculum (e.g., film, computer-assisted instruction (CAI), written discourse); and
- organizational structures for promoting learning (e.g., cross-age tutoring, independent study, Keller plan).

Since teachers can usually select the method through which they will communicate information, an examination of the various effects teaching

methods have on knowledge acquisition is in order. In one major review, Dubin and Tavaggia (1968) reanalyzed the data from nearly 100 studies that had compared variations of lecture and discussion methods at the college level. These investigators were able to make 88 comparisons between traditional lecture and traditional discussion methods, as reported in 36 experimental studies. Of these comparisons, 51 percent favored the lecture and 49 percent favored the discussion method. Dubin and Tavaggia also standardized the criterion test scores reported in the studies, making them comparable from study to study. Across studies the differences between average test performance following exposure to lecture or exposure to discussion methods was very close to zero.

Similar results were found by Dubin and Tavaggia in reviewing comparisons of (a) lecture and lecture-discussion methods in 7 studies, (b) discussion and lecture-discussion methods in 3 studies, (c) lecture methods and supervised independent study methods in 14 studies, and (d) lecture-discussion methods and supervised independent study methods in 9 studies. Their general conclusion was that teaching methods do not differ in effectiveness as measured by achievement on final examinations. However, in most school learning studies, an "equalizer" effect is at work. That is, most mature learners acquire learning from written discourse (the text) as well as from lecture, discussion, or CAI, and so forth. Students who know that they will be taking a final exam compensate for any inadequacies in the way they are taught by relying heavily on the textbook. Thus, it is difficult to determine differences between teaching methods when the textbook helps to equalize achievement.

In another review of different teaching methods, Jamison, Suppes, and

Wells (1974) examined the effectiveness of instructional radio, programmed instruction, and computer-assisted instruction. Their conclusions indicate that instructional radio, supplemented with appropriate printed material, can be used to teach almost any subject as effectively as other classroom methods. However, instructional radio was not uniquely better or worse than other methods. Their review of programmed instruction revealed that it was generally as effective as traditional methods, and that neither traditional nor programmed instruction showed great differences in effectiveness when compared with each other. After examining computer-assisted instruction, they concluded that, "as in other methods of instruction surveyed in this report, no simple uniform conclusions can be drawn about the effectiveness of CAI (p. 55)."

Chu and Schramm (1967) made 421 comparisons of instructional television with traditional methods of instruction. In 308 comparisons, no significant differences in effectiveness were discovered between methods; in 63 comparisons, instructional television appeared to be more effective; in 50 comparisons, traditional teaching methods seemed more effective. Once again, the weight of evidence suggests that when the level of aggregation is the class, different teaching methods have equipotentiality.

As our statements above have indicated, there is sufficient evidence to talk about the approximate equivalence among teaching methods when the acquisition of knowledge is used as a criterion. This, however, does not mean that different teaching methods are equivalent in other ways. For example, it seems reasonable to conclude that programmed instruction can result in a decrease in the amount of time required for a student to achieve specific educational goals. This is an important efficiency factor.

Likewise, at the elementary-school level, computer-assisted instruction has been shown to be a beneficial supplement to traditional instruction; at the same time, however, CAI necessitates increased expenditures for installing computer equipment and programs. Achievement may not be enhanced through the use of small-group discussions, but the attitudes of the students participating in the discussions may be more positive than those of students learning through other methods. As a final example, the highly motivating influence of instructional games on students is an obvious beneficial factor evident to any observer. In summary, we might say that although actual achievement may be equivalent using different teaching methods, other factors such as efficiency, attitude, or motivation may differ greatly.

It is also important to remember that different teaching methods are likely to have different potential for affecting knowledge acquisition when the student is the unit of analysis and student aptitudes are taken into account. Dowaliby and Schumer (1973) examined the relationship of anxiety to student performance in lecture vs. discussion-oriented teaching methods. They concluded that high-anxiety students performed better than low-anxiety students in the teacher-centered lecture situation. Conversely, students low in anxiety performed better than students high in anxiety in the student-centered, discussion situation. In another study, Doty (1967) compared three different types of teaching methods: two structured methods (conventional lecture and audiotaped lecture), and one unstructured method (small-group discussion). She found that if the social needs of students were high, achievement was high when the lecture and discussion methods were used ($r = .40$ and $.65$, respectively). But the higher the social needs of students,

the poorer their performance when audiotaped lectures were used (r = -.53). When student creativity was examined, Doty found that correlations between creativity and achievement in conventional lecture and audiotaped lecture were negative (r = -.21 and -.16, respectively). But [redacted] teaching method used was small-group instruction, the correlation between creativity and achievement was .37.

In summary, evidence shows that although one teaching method may not be superior to another when class averages are examined, individual students with particular aptitudes often perform differently, depending on the specific method used for instruction. Thus, at the level of the individual student, teaching methods have different potential for affecting knowledge acquisition.

The Effects of Curriculum and Methods on Knowledge Acquisition

The fact that significant amounts of knowledge are acquired -- regardless of the curriculum or teaching method chosen for instruction -- has important implications. It means that at some yet-to-be-understood level, the information value of the material presented in the various curricula and methods is often equivalent (cf. Olson, 1972), at least when the class is the unit of analysis. Perhaps information that is conveyed by the various curricula and teaching methods is coded, stored, and retrieved from memory in similar ways by different people, no matter how the information was first obtained. How else can one explain that different students exposed primarily to only one teaching method or one curriculum correctly classify a piece of obsidian as igneous in origin? One student may have learned earth science through programmed instruction; another student may have learned through lecture; and another from a textbook. In one class,

the curriculum may have used a process approach, relying heavily on discovery by the student; in another class, a more deductive curriculum may have been used. In both cases, symbol systems were employed and information was transferred.

For certain students, acquisition of knowledge about earth science may have been enhanced by observing a discussion leader classifying rocks. Others may have watched a film on rock classification in which cues on how to classify were highlighted using special film techniques. For these students, iconic representations of the information may have been established. Still other students may have gained enactive representations of the requisite knowledge when a tutor brought in specimens of particular rocks for handling, or, in the course of a classroom discussion or recitation, the teacher passed out mineral samples to be examined. To use a metaphor from Chomsky, it could be said that although the surface structure of the information being presented appeared to be quite different, the deep structure of the information presented to students was similar. All curricula and methods allowed some students to derive sufficient understanding of the origins of rocks to display appropriate acquisition of knowledge.

Information is presented in numerous forms and with varying degrees of efficiency to the learner, who must attend, rehearse, code, store, generalize, and retrieve it. New kinds of concepts are needed to describe the nature of the learning that goes on when the deep structure of information is processed in the mind of the learner. Attneave (1974) attempted to form such a concept when he suggested that we must posit the existence of language-like representational structures, whose elements have word-like

status that provide meaning to all forms of our experience. To use another metaphor, there must be an elemental internal language which provides meaning for a student's symbolic, iconic, and enactive classroom experiences, much as a computer's machine language processes information from FORTRAN, ALGOL, or COBOL entry languages. At this elemental level of information processing, surface differences among the various curricula and teaching methods disappear. Thus, as an outgrowth of the internal learning process, knowledge acquisition by students of similar ability levels will be roughly equivalent, at least when the content and emphasis of the curricula and methods are similar and the class is the unit of analysis.

The Teacher's Role in Knowledge Acquisition

It is no longer acceptable to take seriously those who minimize the impact of the teacher on the student's acquisition of knowledge (e.g., Coleman, et al., 1966; Jencks, et al., 1972; Mosteller and Moynihan, 1972; Heath and Nielson, 1974). Even if the variance in student outcomes resulting from teacher behavior is only about 20 percent, as is often suggested by these authors, this estimate is an annual rate. Over 12 years of schooling, enormous teacher effects on students would accrue.

An emerging body of literature dealing particularly with children from low-income families at the primary grades indicates that teacher behavior focused on direct instruction results in increased acquisition of student knowledge and skills. Teachers apparently do make a difference, particularly if they act in accordance with some of the common-sense principles that are used by instructional technologists. The data to be presented below will warm the hearts of the Council for Basic Education, which has stressed the

importance of direct instruction for years.

Direct Instruction

By direct instruction is meant a set of teaching behaviors focused on academic matters where goals are clear to students, time allocated for instruction is sufficient and continuous; content coverage is extensive; student performance is monitored; questions are at a low cognitive level and produce many correct responses; and feedback to students is immediate and academically oriented. In direct instruction, the teacher controls instructional goals, chooses material appropriate for the student's ability level, and paces the instructional episode. Interaction is characterized as structured, but not authoritarian; rather, learning takes place in a convivial academic atmosphere. These components of direct instruction will be described in greater detail.

Goal setting. A recent study assigned anthropological ethnographers to 20 more-effective and 20 less-effective classrooms in the second and fifth grades (Tikunoff, Berliner and Rist, 1975). Effectiveness had been determined by measuring 200 teachers' ability to provide instruction in experimental teaching units. These teaching units were specially constructed two-week curriculum packages in reading and mathematics with common objectives, materials, pretests, and posttests. The amount of time each lesson was taught was controlled. The most-effective and least-effective teachers were then chosen for the ethnographic analysis. Ethnographers carefully prepared protocols of reading and mathematics lessons during one week of instruction in each classroom. Neither the ethnographers nor the raters who analyzed the protocols knew the measured effectiveness of the teachers. Analysis of the protocols of the less-effective teachers combined with personal observation

revealed that in many classrooms, the goals of instruction were not clear. That is, many children simply did not know what was expected of them. Lessons might occur, for example, in two-column addition without provision of a structuring statement linking the material to be learned to previous lessons, and without any statement of the expected outcome of the instructional episode. Seatwork often occurred without the students knowing what they were responsible for mastering. Teacher statements about the lesson's objectives, or provision for advance organizers, were rare. Structuring, defined primarily as the teacher's preparation of students for a particular lesson, distinguished between more- and less-effective teachers in the protocols for second and fifth-grade reading and mathematics. Structuring, or goal setting, appears to be related to knowledge acquisition in the classroom and is part of the environment characterized as direct instruction.

Time allocation. Wiley and Harnischfeger (1974) examined the average number of hours of schooling students receive (average daily attendance, x length of school day, x length of school year). Variation by school was dramatically associated with the acquisition of verbal and mathematical knowledge as measured by tests of verbal ability, reading comprehension, and mathematics. Similarly, studies by Bond and Dykstra (1967), Harris and Serwer (1966), and Harris, Morrison, Serwer, and Gold (1968) all report negative correlations between teacher or student absences and achievement.

Stallings' (1975) evaluation of 150 Follow-Through classes revealed similar data.

> Out of a possible 340 correlations between reading achievement and classroom processes, 118 were significantly related at the .05 level. Of these, the most strongly correlated variables suggest that the length of the school day and the average time a child spent engaged in a reading activity were related to

high reading scores in both first and third grade (p. 6).

And, in reviewing her data on mathematics achievement, she noted:

> Out of a possible 340 correlations between math achievement and classroom processes, 108 were significantly related at the .05 level. Of these, the most strongly correlated variables suggest that, as in reading, the length of the school day and the average length of time each child spent in math activities were related to higher math scores in both First and Third grades (pp. 6-7).

In the national sample Stallings used for her evaluation report, the length of the school day varied as much as two hours per day among schools. Instructional time appears to be a powerful factor in accounting for acquisition of knowledge in the classroom.

Studying the time variable has led these writers to observe classroom allocations of time from both the teacher and student standpoints. A reliable measure of time allocation by the teacher is easy to obtain. Typically, a teacher in the primary grades allocates 50-100 minutes a day to reading, and 30-50 minutes to mathematics. From the analysis of teaching protocols taken in the classes of more- and less-effective teachers, it was noted that when teachers become fixed by their time allocation, starting and ending lessons by the clock rather than on the basis of student behaviors, or when teachers rushed students for any reason, they appeared to be less effective in helping students achieve in academic areas (Tikunoff, Berliner, and Rist, 1975). Also, if the teacher engaged in abrupt shifts during the time allocated for a particular subject, such as switching from individual instruction in reading to behavior management, then to reading the principal's message, and then to large-group instruction in reading, they were less effective teachers (Tikunoff, Berliner, and Rist, 1975). Immature learners cannot thrive when choppy or disjointed lessons occur within a

given instructional period.

While the teacher is allocating and using time, what is the student doing? The variable called active learning time -- synonymous with engagement, attention, and on-task behavior -- can be easily coded. Every time a student is apparently on-task during a teacher's allocated time for a lesson, a stop watch can be run. When the student is apparently off-task (looking out the window, going to the rest rooms, doodling, talking, etc.), the observer can stop the watch. Recently, in a suburban school, a typical child's active learning time was clocked during 45 minutes of seatwork (learning decoding skills in a workbook). The child was engaged with the learning task 3-1/2 minutes. During a subsequent teacher-led, small-group session for developing reading skills, the child was apparently engaged during 20 of the 25 minutes allocated.

To understand the process by which knowledge is acquired in the classroom, at a minimum, one must be able to describe the duration of the treatment. The typical 180 days of schooling must be reduced by teacher and student absences due to illness, strikes, bussing difficulties, parent conferences, etc. This result must be multiplied by the number of minutes per day allocated by a teacher for instruction in a subject. The new figure must be adjusted for the number of minutes a student allocates to active learning time. After these computations have been made, one is likely to find that academically oriented instructional activity accounts for a trivial amount of the total yearly school activities at the primary grades. Data from McDonald et al. (1975) provide estimates that the median hours of on-task reading and mathematics instruction for second- and fifth-grade students is well under 70 hours per school year. Within-class and between-

class variation is, however, quite large. Given this state of affairs, even slight increases in active learning time would appear to be logically related to increased student acquisition of knowledge. Empirical data from many sources is accumulating to support this proposition (Bloom, 1974).

It may be concluded that at the primary grades, more academic knowledge is acquired by students in classes where (a) the schools and teachers have allocated more time for academic instruction; (b) the time used for lessons is continuous rather than disjointed; (c) teachers are activity oriented rather than bound by the clock as a guide for the length of the lessons; and (d) students are actively involved in the instructional episode so that differences between the teachers' and the students' allocation of time are minimized.

Academic focus. Time is, of course, an empty vehicle. To produce academic outcomes, it must be filled with academic behaviors. For example, Stallings and Kaskowitz (1974) studied process variables related to reading and mathematics outcomes in first- and third-grade Follow-Through classes. Table 3 presents selections from their data. The conclusions are in the directions expected. Academic activities and behaviors were positively related to the acquisition of reading and mathematics knowledge. Nonacademic classroom activities were negatively related to the acquisition of reading and mathematics knowledge, and, of course, when classroom management problems were frequent, achievement was lower. As Rosenshine (1976, in press) notes for the Follow-Through data as a whole,

> There was no nonacademic activity which yielded positive correlations with reading and mathematics. This last sentence is somewhat surprising because it has frequently been argued that some of these other activities contribute to reading achievement by motivating students or by providing additional stimulation or practice. Such indirect enhancement was not evident in this study.

INSERT TABLE 3 HERE

Content coverage. The academic focus of classroom time is similar to the opportunity-to-learn variable so important in Carroll's (1963) theory, and the mastery learning and Keller plan programs. The academic focus provides for content coverage and emphasis, the two critical variables that emerged from the analyses of the effects of curriculum on the acquisition of knowledge. Studies by Armento (1975), Chang and Raths (1971), Rosenshine (1968), and Shutes (1969), all found significant relationships between their assessment of the content covered by teachers and student achievement. Moreover, for Armento and Rosenshine, the correlations between the content that was covered and student achievement were larger than those obtained for any other teacher behavior variables.

McDonald's (1975) data from almost 100 second and fifth grade classrooms also support these findings:

> ...at both the second and fifth grade, the amount of mathematics covered is a critical factor. This result should not be surprising. Mathematics is an organized body of content, and tests constructed to measure what students learn in mathematics are organized around this content. If students have not been taught...some...concept or procedure, they simply do not do well on those portions of the test relevant to that topic. Teaching procedures which maximize the range of content covered are teaching procedures likely to be effective [p. 27].

Monitoring student activities. Although findings are not always consistent within and between studies, a trend exists in the data pointing toward the need for adult monitoring of student progress. Some results from the observations of Stallings and Kaskowitz (1974), presented in Table 4, provide pertinent information. One implication of this table is that independent seatwork or independent small-group work is an inappropriate organizational

structure for elementary school classrooms, while large-group instructional settings appear to be more conducive to acquisition of reading and mathematics knowledge. Such is the opinion of Rosenshine (1976, in press): "The results do not support 'individualizing' and provide support, particularly in the third grade, for the use of large groups." But Rosenshine recognizes that these data also imply that when a teacher or other adult can monitor student activities (e.g., large-group instruction vs. independent seatwork), achievement is higher.

INSERT TABLE 4 HERE

As was noted above, one student spent 3-1/2 minutes engaged in actively learning during the 45 minutes of independent seatwork allocated to her by the teacher. This provides an estimate of approximately 8 percent apparent utilization of time. In small-group work, with the teacher, 20 of 25 minutes was recorded as engaged time. This represents a utilization level of about 80 percent of the allocated time. The difference in utilized time is parsimoniously accounted for by the absence or presence of a monitor of student activities.

Soar (1973) also studied grouping patterns in elementary school Follow-Through classes and found similar evidence. He discovered that when students worked in a group under adult supervision, correlations with achievement were positive and often significant. On the other hand, when small groups met without an adult, correlations between this organizational pattern and achievement were negative and often significant. A simple fact may be inferred from the studies cited: many students do not engage in on-task behavior when a teacher or other adult is not monitoring their academic activities.

Individualized instructional programs make extensive use of independent seatwork activities. However, before advocates of individualized programs rise in righteous indignation at the interpretations of the data given above, we should note that some teacher training that accompanies individualized programs prepares the teacher to oversee student learning. Pittsburg's Individually Prescribed Instruction (IPI) emphasizes the need for a travelling teacher or travelling aide -- someone who constantly monitors each student's classroom behavior. Unfortunately, in the implementation of many individualized programs, students' independent seatwork or independent small-group work is monitored infrequently. Lower levels of acquired knowledge will result for students in classrooms where infrequent monitoring is normative.

Questioning. Table 5 from Stallings and Kaskowitz (1974) presents data that are substantiated in other studies. Open ended questions, i.e., questions high in the Bloom Taxonomy, are negatively related to student achievement. So are nonacademic questions. Only academically focused, direct questions at lower levels of the Bloom Taxonomy resulted in increased acquisition of knowledge by students. Using a similar sample of low-income students, Soar (1973) also found that factors with high loadings from variables such as convergent questions, drill, or questions that have single answers usually correlated positively with achievement. Factors with loadings from variables like divergent questions and open-ended questions usually correlated negatively with achievement.

INSERT TABLE 5 HERE

Despite Piaget's theory, which cautions against the use of higher cognitive questions with pre-operational or concrete-operational children, there has been an emphasis on training teachers to use higher cognitive questions. Recent experimental work, along with the correlational data presented, may reverse this trend. Two well-designed experiments have demonstrated that the percentage of cognitive questions asked by teachers per lesson has no discernible effect on elementary school students' acquisition of knowledge (Gall, Ward, Berliner, Cahen, Elashoff, Stanton, and Winne, 1975; Program on Teacher Effectiveness, 1975).

Rosenshine (1976, in press) has also brought together data on the association between the kinds of student responses made to teacher questions and achievement. As might be expected, academic responses are positively correlated with outcomes; nonacademic responses and responses to open-ended questions are negatively correlated with outcome measures. Brophy and Evertson (1974) also examined student responses and detected an interesting interaction. For lower socioeconomic status students, the percent of correct answers was positively correlated with achievement, while for higher socioeconomic status children, the percent of wrong answers was a positive predictor. As with curriculum and teaching methods, there are main effects and interactions, depending upon whether the class or the student is the unit of analysis.

Feedback. From studies reviewed in Rosenshine (1971) and Duncan and Biddle (1974), Gage and Berliner (1975) found 14 studies on the relationship between teacher praise and student achievement. Eight of these studies yielded positive correlations with achievement, while six studies yielded

negative correlations with achievement. No clear relationship between feedback in the form of praise and student acquisition of knowledge was discernible from these studies. From studies of feedback in the form of a teacher's criticism of students, Gage and Berliner (1975) found thirteen studies that yielded negative relationships with student achievement and three studies that yielded positive relationships. Frequent criticism by teachers would appear to be a negative predictor of student achievement.

Stallings and Kaskowitz (1974) also studied praise and criticism, and their data help to refine the conclusions drawn about the effects of these forms of feedback. They categorized praise or criticism as academic or nonacademic in focus (e.g., praise for reading work vs. praise for working well in groups; or, criticism for mathematics performance vs. criticism for music activities). The relationship with student achievement is generally positive for both praise and criticism when such feedback is focused on academic activities. The relationship of both these teacher-feedback dimensions to student achievement is mixed or negative when given for nonacademic student behaviors.

It appears that feedback, whether praise or criticism, helps students acquire knowledge if it is academically focused. This is consistent with the idea that a direct instructional emphasis in the classroom is a major determinant of student achievement.

Once again, a distinction must be made between the class and the student as units of analysis. At the classroom level of aggregation, these feedback dimensions appear to have similar effects when academically focused, but at the student level of analysis, praise and criticism seem to have different effects on different types of students. As one example of this, introverts

and extroverts appear to respond very differently to praise and criticism (Forlano and Axelrod, 1937; Thompson and Hunnicutt, 1944).

Atmosphere. An environment that stresses academic achievement, making use of many of the components of direct instruction mentioned earlier, need not be authoritarian, coercive, or aversive. Among the characteristics of the more effective classrooms reported by ethnographers were conviviality, cooperation, democracy, and warmth. Less-effective classrooms showed more evidence of teachers' belittling and shaming students and use of sarcasm. The ethnographic protocols were also analyzed for competitiveness, but this variable did not distinguish between more-effective and less-effective teachers. The ethnographic analysis also confirmed an obvious fact: in classes where behavior management problems exist, a warm atmosphere cannot develop, and direct instruction cannot take place. Classes that are out of control are invariably classes where little academic learning takes place (Tikunoff, Berliner, and Rist, 1975).

The above description of effective-classroom teaching, in which the successful classroom environment is characterized by an emphasis on academic achievement, appears to be an unusually simple way to explain the acquisition of knowledge in the classroom. Teaching behavior which is not directly aimed at furthering academic achievement of the kind measured by standardized achievement tests, will not result in much growth in knowledge acquisition as measured by those kinds of tests. Teachers who make a difference in students' achievement are those who put students into contact with curriculum materials and find ways to keep them in contact with the knowledge to be acquired through their teaching methods and behaviors.

Though it may be easy to dismiss the data presented as nothing but common sense, it is clear from out observations of classrooms that common sense is not necessarily common practice. And even these simple descriptions of successful environments for classroom learning are complicated by the fact that data are not consistent within and between studies. Moreover, when we try to explore how individual students process the information to be acquired -- their ability to encode, retrieve, decode, and transfer information -- the classroom becomes a very complex environment in which to work.

Studying Classroom Learning

By addressing the molar environment characterized as direct instruction, and using highly selected data relating components of that environment to student achievement, this paper avoided the problems that arise when classroom teaching is approached in a more molecular fashion. Studies that attempt to examine single skills or particular behaviors of teachers and relate those variables to student outcomes have certain substantial inadequacies (Berliner, 1975).

Some of these problems relate to the issue of appropriateness of teacher behavior, the unit of analysis for the independent variable, the stability of teacher behavior, and construct validation. (Not mentioned at this time are the equally knotty problems associated with the criterion measure used to assess student achievement and the statistical methods used to measure change in students' performance.)

Appropriateness of Teacher Behavior. Many studies of the acquisition of knowledge in the classroom count or rate behavior and do not deal with

the crucial question of appropriateness of teacher behavior -- a qualitative dimension that is difficult to come to grips with. When observing in a classroom, one becomes acutely aware of the difference between a higher cognitive question asked after a train of thought is running out, and the same type of question asked after a series of lower cognitive questions have established a foundation from which to explore higher order ideas. Teachers sometimes ask inane questions. Teachers have been seen responding to student-initiated questions with irrelevant information. Teachers sometimes achieve a high rate of probing student responses to questions, seemingly without regard for the student or the kind of initial response given to the question. Some students are embarrassed by the probing; with other students, the probes occurred at inappropriate times, and sometimes probes were not used when the situation seemed to cry out for them. At other times, the teachers' probing questions may have been as skillful as Socrates' but only their frequency was recorded. Before we can adequately assess how particular teacher activities contribute to a student's acquisition of knowledge and skills, we must learn to confront this qualitative dimension where value judgments about appropriate use of skills enters into our description of classroom phenomena.

The Unit of Analysis for the Independent Variable. Another problem one becomes acutely aware of in studying teacher effectiveness is the problem of the unit of analysis for characterizing the independent variable. Is a single teacher question the appropriate unit? Is a question, along with the wait-time which follows, the appropriate unit? Or does a teacher question, wait-time, and student answer make up the unit which best characterizes the

independent variable? Teachers often follow strategies of long duration. They may conduct an inductive lesson where the meaningful unit of analysis may be a one-hour or one-week episode that is concerned with the conservation of matter. The individual questions, reinforcers, probes, and student responses may be trivial aspects of the overall episode. Until we have adequate conceptions of the unit of analysis of our independent variables, we may need to remain at a more molar level for describing classroom processes.

Stability of Teacher Behavior. When describing a "good" teacher, many people use a term such as "flexible." Such teachers are expected to change methods, techniques, and styles to suit particular students, curriculum areas, time of day, etc. That is, the commonly held standard of excellence in teaching implies a teacher whose behavior is inherently unstable. Needless to say, this poses a problem for an observer trying to understand a teacher's customary and usual ways of teaching. A recent review of the stability of teacher behavior (Shavelson and Dempsey, 1975) pointed out that many of the skills and behaviors that have been studied in research on teacher effectiveness are unstable over occasions. A rather large number of low and even negative stability coefficients were found. This means that the independent variables in many studies of teacher effectiveness were often not fair indicators of a teacher's typical behavior. Researchers seem so eager to capture variables for data analysis with rating scales and frequency counts, that they apparently forget to check if their methodology is appropriate to the phenomena they are interested in studying!

Construct Validation. Scientific understanding of any phenomenon requires a descriptive language that uses concepts having common meaning among the scientists working in the same area. Among researchers on teacher effectiveness, this criterion is not currently being met. A concept such as "warmth" does not have the same meaning from study to study. A teacher's warmth may be measured by self-report, student-report, observer-rating, frequency-count of smiles, percentage of gestures regarded as affectionate, or numerous other indicators. If these various imprecise and imperfect measures of warmth were intercorrelated, one could perhaps begin to understand the construct which is now so glibly used but so poorly defined. Extensive construct validation must take place in research on teaching; otherwise, the imprecision of the language used to describe phenomena of interest will continue to retard empirical study.

For these and other reasons, an organismic description of the environment which affects student achievement in classrooms seems more useful than a molecular approach. Across many studies, using different observation instruments and different statistical techniques, a convergence around the concept of direct instruction is evident in the literature; however, this promising concept will also need more clear and precise definition if it is to be useful in future research on classroom learning.

Learning Theory and Classroom Learning.

This paper purposefully did not rely upon the concepts and principles derived from learning theory and research to describe how knowledge is acquired in the classroom. This was avoided for many reasons. Skinner's description of classroom learning appears to be woefully inadequate. For example, he says, "The student who is paying attention to a lecture or text

is reinforced when the words he hears or sees correspond to responses he has anticipated -- an important ingredient in listening or reading with 'understanding.' (1968, p. 157) " If true, this description could at best account for only a small percentage of classroom learning. Likewise, the concepts and principles of contiguity theory, respondent learning theory, and observational learning theory also fail to elicit from the observer a sense of certainty that such concepts adequately describe classroom learning. Classrooms are dynamic and complex environments. A classroom often constitutes a confusing milieu to the observer trying to make sense out of what is going on. Praise and criticism, when defined as positive reinforcement and punishment, fail to elicit the same response from classroom learners as they do from learners in the laboratory. In some classes, students learn more from the errors they make than from their success in answering questions. Students are often observed watching an apparently flawless demonstration of how to subtract without afterwards showing any evidence of having acquired that knowledge.

Classrooms are not only quantitatively different from laboratory settings; they are also qualitatively different, and thus may need to be understood by conceptual frameworks other than those provided by traditional learning theory (cf. McKeachie, 1974). One exception to this negative view of the efficacy of the concepts and principles derived from learning theory, however, is the current work in cognitive learning theory using an information processing perspective. Learners in all kinds of classrooms must organize information and give meaning to it as they go through school. An understanding of the ways in which processing and memory systems work with organized and meaningful verbal knowledge is likely to affect how instruction

is carried out. However, until the internal processing mechanisms of learners are better understood, molar descriptions of the effects of the external environment on the acquisition of knowledge will have to suffice, and most traditional learning theory should be disregarded as an important source of concepts for understanding classroom learning.

Conclusion

Major factors in the process of knowledge acquisition in the classroom are the content and emphasis of the curriculum in use and the content coverage and emphasis given through the teaching methods employed. The classroom behavior of a successful teacher is characterized by direct instruction, whereby students are brought into contact with the curriculum materials and kept in contact with those materials until the requisite knowledge is acquired. At the primary grades, direct instruction includes goal setting; allocation of sufficient time to reach goals; motivating students by appropriate choice of curriculum materials, teaching methods, and teaching behaviors so that active learning time is high; providing an academic focus; and monitoring student activities during the allocated instructional time. The successful teacher asks direct questions and provides positive and negative feedback to students on academic matters. The atmosphere for successful direct insturction is warm, and student behavioral problems are low in frequency.

In general, studies of isolated teacher skills and behavior in natural classroom environments have not provided much information about how knowledge is acquired in the classroom. This state of affairs will continue until investigators engaged in research on teaching have learned how to work

with the concept of appropriateness, define a unit of analysis for the study of teaching, obtain stable estimates of teacher behavior over occasions, and perform extensive construct validation.

Because the classroom is such a complex and dynamic environment, traditional variables derived from theories of learning are insufficient in accounting for how students acquire knowledge in the classroom. Information processing approaches to the study of learning are promising but still in their infancy.

If today's schools are failing to provide students the knowledge and skills they need, as many critics contend, some of the blame may be placed on the failure of educators to understand a very simple fact. That is, almost all teacher behaviors that increase a class's engagement with the content of almost any curriculum, communicated to students through almost any teaching method, will increase student achievement. Complexity only arises when we focus on individual students who may need different curriculum, specially chosen teaching methods, and exposure to a unique set of teaching behaviors in order to optimize their learning. Thus, the factors related to knowledge acquisition in the classroom may be viewed as both disarmingly simple, and frightfully complex, at the same time.

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TABLE 1

COMPARISONS OF INNOVATIVE AND TRADITIONAL CURRICULUM

(After Walker and Schaffarzick, 1975, p. 92)

Content bias of the tests	Number of independent comparisons	Results		
		Innovative curriculum superior to traditional curriculum	Traditional curriculum superior to innovative curriculum	Innovative curriculum equal to traditional curriculum
Test of knowledge acquired favored the innovative curriculum	52	44	1	7
Test of knowledge acquired favored the traditional curriculum	30	5	9	16
Content bias of the tests could not be determined	16	4	3	9

TABLE 2

TREATMENT MEANS ON THREE MEASURES OF OUTCOME IN TWO CURRICULUM AREAS FOR DIFFERENT LEVELS OF VERBAL ABILITY (After Chastain, 1970)

Tests of Acquired Knowledge	Initial Verbal Ability	Means In Foreign Language Curriculum	
		Audio-Lingual Habit Theory	Cognitive Code Learning Theory
Listening Comprehension	High	15.80	20.00
	Low	17.69	14.33
Speaking Analysis	High	35.00	40.62
	Low	41.62	34.00
Language Aptitude	High	25.50	22.31
	Low	18.55	27.60

TABLE 3

CORRELATIONS BETWEEN CLASSROOM PROCESS VARIABLES AND STUDENT ACHIEVEMENT
(After Stallings and Kaskowitz, 1974)

VARIABLES	GRADE AND SUBJECT			
	First Grade Classes (N=108)		Third Grade Classes (N=58)	
	Math Achievement	Reading Achievement	Math Achievement	Reading Achievement
Approximate number of children involved in mathematics	.35	.29	.60	.31
Approximate number of children involved in reading	.32	.40	.50	.32
Percent of instances in which an academic activity occurs	.21	.35	.59	.42
Total academic verbal interactions	.41	.42	.50	.29
Number of activities concerned with numbers, math, or arithmetic	.29	.26	.59	.33
Number of activities concerned with reading, alphabet or language development	.18	.40	.40	.23
Number of activities concerned with arts and crafts.	-.23	-.29	-.26	-.03
Number of activities concerned with music, story telling and dancing	-.03	-.16	-.52	-.39
Amount of active play	-.26	-.23	-.29	-.10
Amount of classroom management	-.33	.23	-.10	-.17

TABLE 4

CORRELATIONS BETWEEN GROUPING PRACTICES AND STUDENT ACHIEVEMENT

(After Stallings and Kaskowitz, 1974)

GROUPING PRACTICE	GRADE AND SUBJECT			
	First Grade Classes		Third Grade Classes	
	Math Achievement	Reading Achievement	Math Achievement	Reading Achievement
Small group of children working independently in math	-.14	-.22	-.46	-.41
Small group of children working independently in reading	-.26	-.19	-.23	-.23
Teacher with large group	.07	.15	.47	.54
Large group of children with any adult	.10	.09	.42	.48

TABLE 5

CORRELATIONS BETWEEN ADULT QUESTIONING
AND
STUDENT ACHIEVEMENT

(After Stallings and Kaskowitz, 1974)

	GRADE AND SUBJECT			
	First Grade Classes		Third Grade Classes	
VARIABLE	Math Achievement	Reading Achievement	Math Achievement	Reading Achievement
Adult academic commands, requests, and direct questions to groups of children	.10	.29	.54	.51
Adult academic commands, requests, and direct questions to individual children	.23	.29	.30	.10
Adult non-academic commands, requests, and direct questions to individual children	-.31	-.25	-.47	-.37
Adult open-ended questions to children	-.03	-.11	-.35	-.31